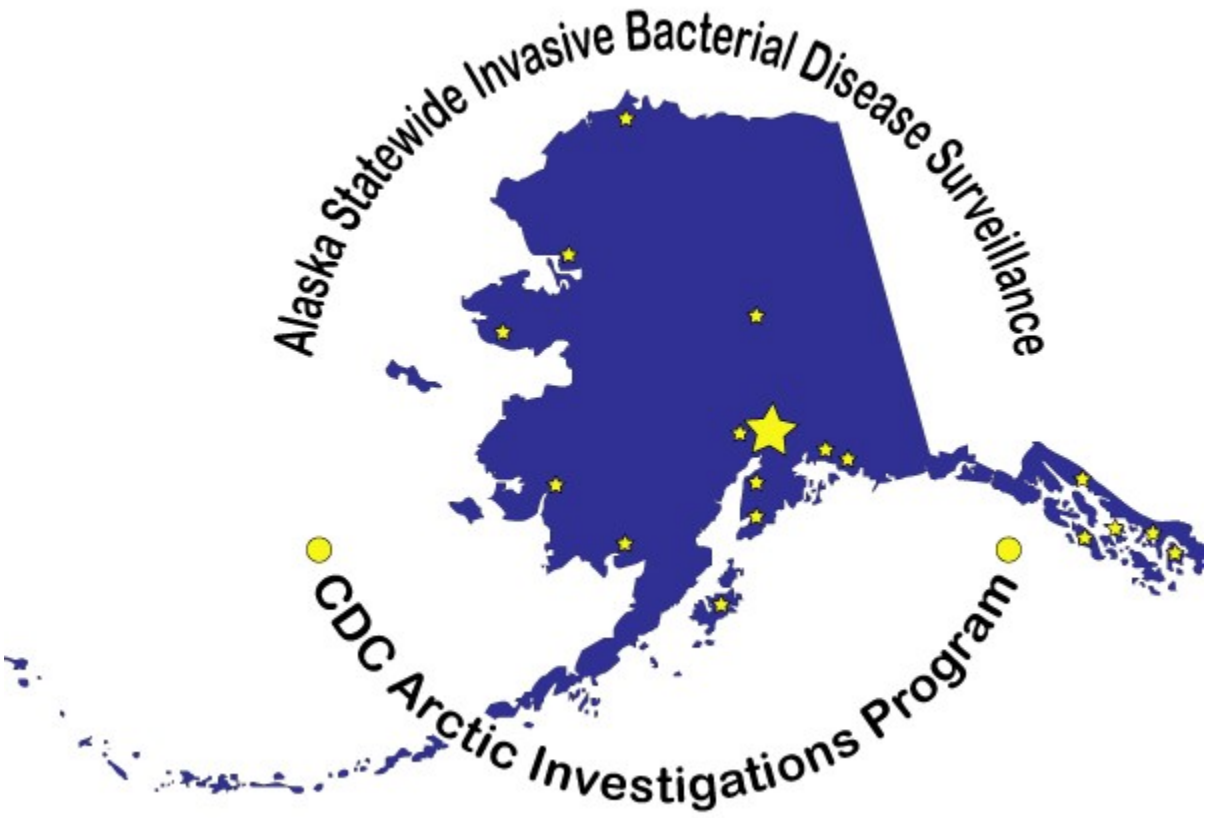

Surveillance of Invasive Bacterial Disease in Alaska, 2015

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Alaska Statewide Invasive Bacterial Disease

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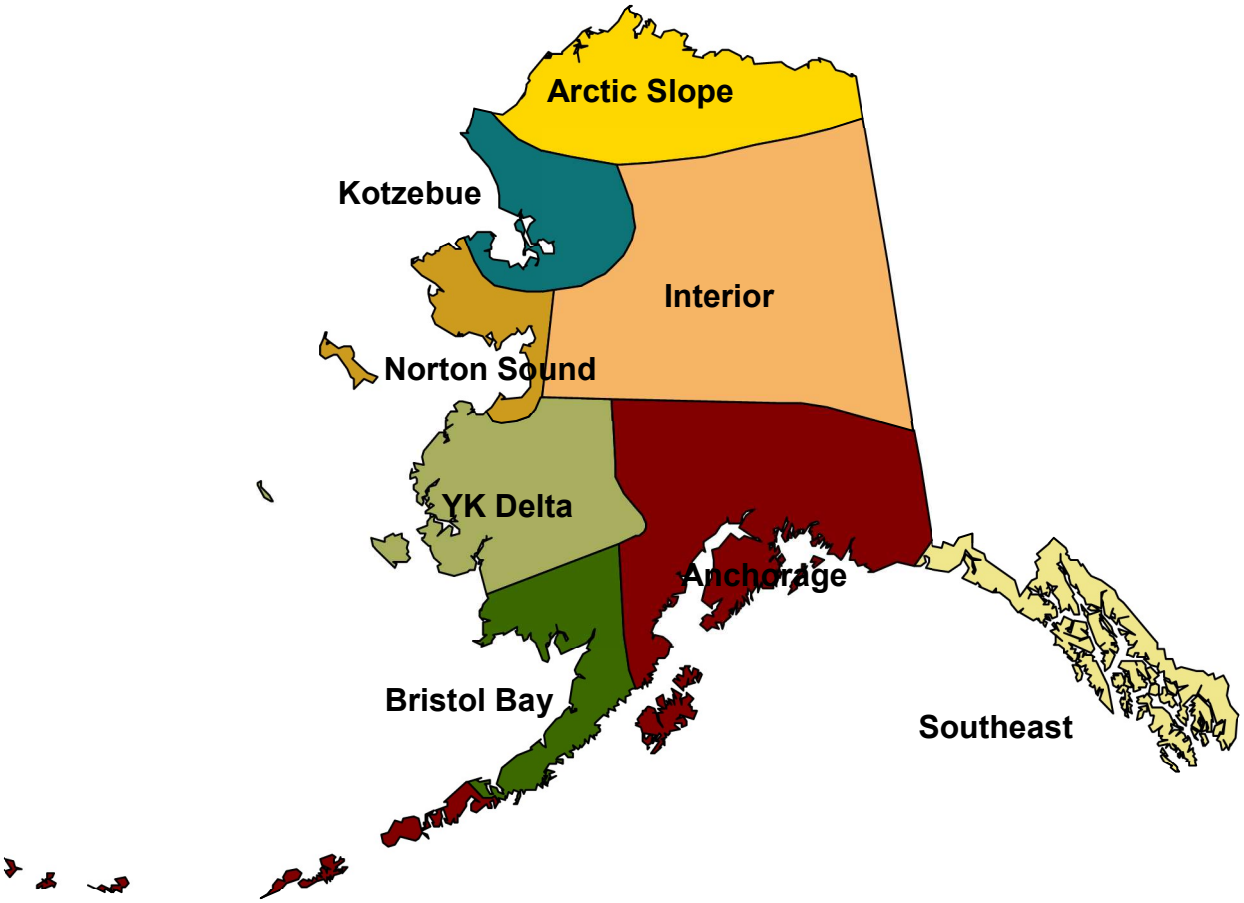
Summary

The Centers for Disease Control and Prevention's Arctic Investigations Program (AIP) in Anchorage, Alaska, maintains a statewide surveillance system for invasive diseases caused by *Streptococcus pneumoniae*, *Haemophilus influenzae, Neisseria meningitidis,* and groups A and B streptococci. Laboratories throughout the state are requested to send to AIP any isolates of these organisms recovered from a blood culture, CSF, or other normally sterile site in an Alaska resident. Isolate identification is confirmed and, when appropriate, serotyped and tested for antimicrobial susceptibility. The objectives of this system are to provide information on disease rates within the state, monitor the emergence of antimicrobial resistance, and to monitor the effectiveness of implemented vaccine programs, such as the 23-valent pneumococcal polysaccharide vaccine, the pneumococcal conjugate vaccine and *Haemophilus influenzae* type b vaccines.

Figure 1: Invasive Bacterial Disease Surveillance Regions – Alaska, 2015



In 2015, the total numbers of cases of invasive disease caused by these organisms reported to AIP were 100 *S. pneumoniae*, 22 *H. influenzae*, 4 *N. meningitidis*, 91 group A *Streptococci*

(GAS) and 60 group B *Streptococci* (GBS). Alaska Native people had higher rates of disease overall than non-Native people for all surveillance organisms. Rates of invasive pneumococcal disease were highest in the YK Delta and Kotzebue regions. Rates for each organism by region are presented in the following table.

Table 1: Surveillance Organisms Reported by Region – Alaska, 2015

Region	*S. pneumoniae* n (rate*)	*H. influenzae* n (rate*)	*N. meningitidis* n (rate*)	GAS n (rate*)	GBS n (rate*)
Anchorage	59 (12)	10 (2)	2 (0.4)	60 (12.2)	37 (7.6)
Arctic Slope	0 (0)	0 (0)	0 (0)	3 (33.9)	0 (0)
Bristol Bay	1 (13.9)	0 (0)	0 (0)	1 (13.9)	1 (13.9)
Interior	12 (10.7)	1 (0.9)	2 (1.8)	11 (9.8)	11 (9..8)
Kotzebue	4 (46.8)	1 (11.7)	0 (0)	3 (35.1)	2 (23.4)
Norton Sound	2 (19.9)	0 (0)	0 (0)	2 (19.9)	0 (0)
Southeast	7 (9.4)	1 (1.3)	0 (0)	5 (6.7)	6 (8.1)
YK Delta	15 (56.6)	9 (33.9)	0 (0)	6 (22.6)	2 (7.5)
Total	100 (13.6)	22 (3)	4 (0.5)	91 (12.3)	59 (8)

*Cases per 100,000 population

Introduction

AIP conducts statewide surveillance of invasive *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Neisseria meningitidis*, and groups A and B *Streptococcus*. This program is part of a passive, laboratory-based surveillance system in which laboratories from all hospitals throughout the state are encouraged to participate. The population included in the AIP surveillance is the State of Alaska, which totaled 737,625 persons in 2015 [1]. Case detection occurs year-round as participating laboratories send isolates recovered from sterile sites to the AIP laboratory in Anchorage; materials and forms for isolate shipment and data collection are provided to each laboratory by AIP. Demographic and clinical information on the cases are collected from a review of medical records. At year-end, AIP asks that each laboratory review their records and provide information on any cases that may have been overlooked. In 2015, 23 laboratories in Alaska participated in the invasive disease surveillance system, either by sending isolates to the AIP laboratory throughout the year, conducting year-end record reviews, or both. Beginning in January, 2007, invasive *S. pneumoniae*, GAS and GBS became reportable conditions to the State of Alaska Division of Public Health (DPH). Reports of cases of disease caused by these organisms, along with cases of invasive *H. influenzae* and *N. meningitidis* which were previously reportable, are shared between AIP and DPH.

AIP defines a case of invasive *S. pneumoniae, H. influenzae*, *N. meningitidis*, GAS or GBS as an isolate of the bacteria from a normally sterile site, including blood, cerebrospinal fluid, pleural fluid, peritoneal fluid or joint fluid that has been taken from a resident of Alaska. In addition, for GAS, isolates are requested from deep tissue infections such as might be collected from surgical debridement of cases of necrotizing fasciitis.

Invasive Pneumococcal Disease

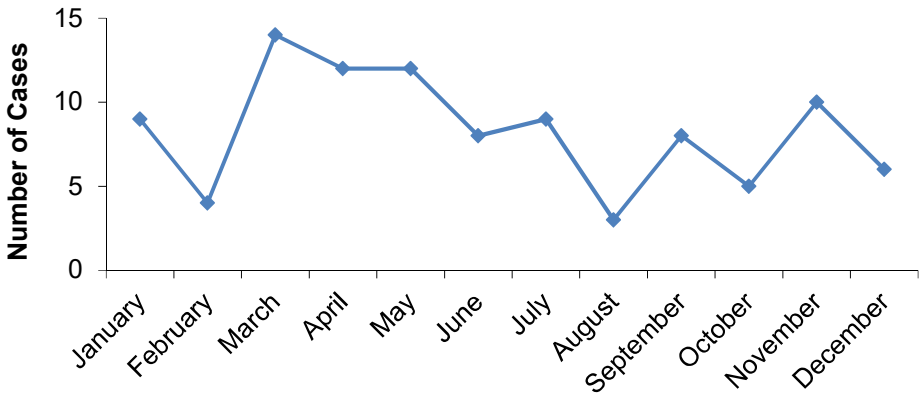
Overall Incidence

A total of 89 pneumococcal isolates were received at AIP in 2015. An additional 9 cases were detected through shared surveillance with the State DPH and 2 cases were reported by laboratories during the annual audit for a total of 100 cases of invasive pneumococcal disease. The overall rate for invasive pneumococcal disease in 2015 was 13.6 cases per 100,000 persons per year. Alaska rates for 2015 were higher than the Active Bacterial Core Surveillance (ABCs) 2015 national projected rate of 9.2/100,000 [2]. ABCs is a surveillance system operated in 10 states which covers a population of up to 42 million persons.

Seasonality

Invasive *Streptococcus pneumoniae* cases were identified in each month of 2015. The largest number of cases (n=14) was reported in March.

Figure 2: Invasive Pneumococcal Disease, by Month of Culture - Alaska, 2015



Race

In 2015, the state population was comprised of 19% Alaska Native people *(Alaska Natives alone or in combination 144,274 non-Natives 593,351)* [1]. Of all reported *S. pneumoniae* cases in 2015, 43% occurred among Alaska Native people for a total of 43 cases; the age-adjusted rate was 32/100,000 persons per year. Fifty-seven cases occurred among the non-Native population for an age-adjusted rate of 8.6/100,000 persons per year. The rate ratio of age-adjusted rates of *S. pneumoniae* disease for the Alaska Native population compared with the non-Native population in 2015 was 3.7.

Table 2: Invasive *Streptococcus pneumoniae* Cases by Race – Alaska, 2015

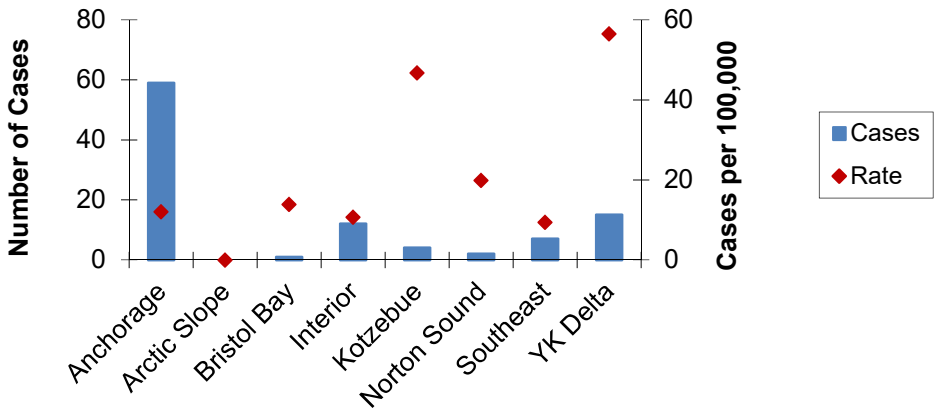
Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	43 (43)	32	61%	7 (16)
Non-Native†	57 (57)†	8.6	67%	7 (13)‡
Total	100		64%	14 (14)

*Cases per 100,000 per percent distribution of Alaska 2010 population
†Includes 6 cases for which race was unknown
‡Outcome unknown in 2 cases

Region

The highest percentage (59%) of invasive pneumococcal disease cases occurred in the Anchorage area in 2015. Rates of disease, however, were highest in the YK Delta (56.6/100,000 persons per year) and the Kotzebue region (46.8/100,000 persons per year).

Figure 3: Invasive Pneumococcal Disease, Cases & Rates by Region - Alaska, 2015

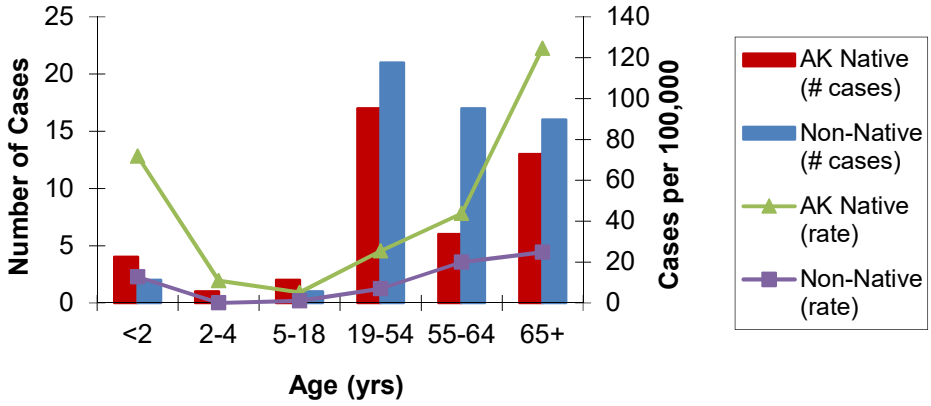


Age

Cases occurred in all age groups in 2015 ranging from 6 months to 94.6 years with a median age of 58 years. Overall, the highest rates of disease occurred in children less than two years old and adults 65 years and older.

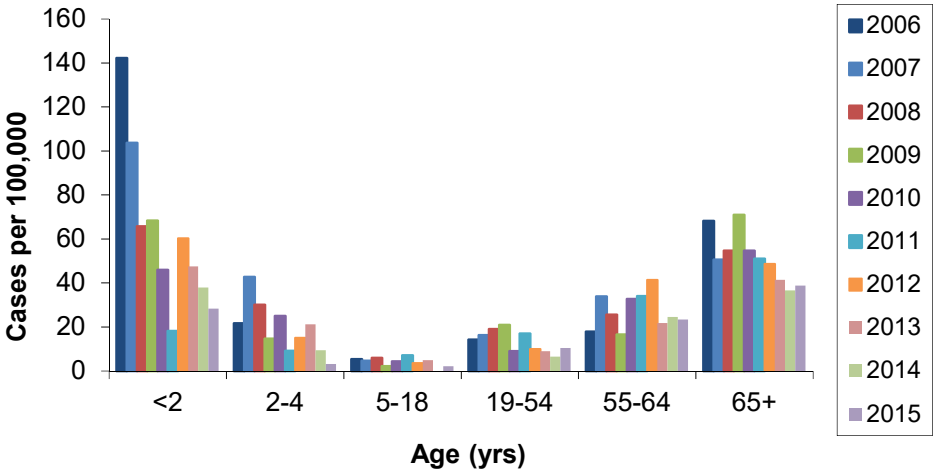
When stratified by age and race, the highest rates of disease in 2015 occurred in Alaska Native adults 65 years and older (124.7/100,000 persons per year).

Figure 4: Invasive Pneumococcal Disease, Cases & Rates by Age Group & Race - Alaska, 2015



Since the initiation of a pneumococcal 7-valent conjugate vaccine program in 2001, overall rates of invasive disease declined dramatically in children less than 2 years of age [3]. In 2008, the rate of invasive pneumococcal disease in children less than 2 years declined to 65.6/100,000 which was the lowest rate observed in this age group since introduction of the 7-valent vaccine. Following introduction of a 13-valent conjugate vaccine in 2010, rates of disease observed in children less than 2 years old declined to 18/100,000 in 2011. In 2012, however, disease rates in this age group increased to 60.3/100,000 due to disease caused by serotypes not included in the current vaccine. In 2015, rates have declined to 28.3/100,000.

Figure 5: Invasive Pneumococcal Disease by Age Group - Alaska, 2006-2015



Although pneumococcal disease rates dropped initially in AK Native and non-Native children less than 2 years of age after introduction of the 7-valent vaccine, the rates of disease in AK Native children less than 2 years trended upward from a low of 93.6/100,000 in 2001 to 335.9/100,000 in 2006. This increase in rates was due primarily to disease caused by serotypes not contained in the pneumococcal conjugate vaccine [4,5]. In 2009, rates of disease in AK Native children less than 2 years declined to 87.1/100,000 which was the lowest rate since the

introduction of the seven-valent pneumococcal vaccine. After introduction of the 13-valent vaccine in 2010, rates declined to 30.7/100,000 in 2011, however, increased to 177.5/100,000 in 2012. Rates declined to 70.1/100,000 in 2014 and were similar in 2015 (71.9/100,000). One of the four cases that occurred in AK Native children less than 2 years old during 2015 was caused by a serotype contained in the 13-valent vaccine. Rates of invasive disease in non-Native children less than 2 years declined during the same time period reaching 26.8/100,000 in 2005, and following an increase to 64.4/100,000 in 2007, declined in 2008 to 6.2/100,000. In 2009, the rate of disease in non-Native children less than 2 years increased to 60.3/100,000, but declined to 13/100,000 in 2012 with use of the 13-valent vaccine. Following an increase in 2013 (26.3/100,000), rates in non-Native children less than 2 years were similar in 2014 (25.9/100,000), but declined in 2015 to 12.8/100,000; one of two cases was caused by a non-vaccine serotype and the serotype for the second case was unknown.

Figure 6: Invasive Pneumococcal Disease in Alaska Natives, by Age Group - Alaska, 2006-2015

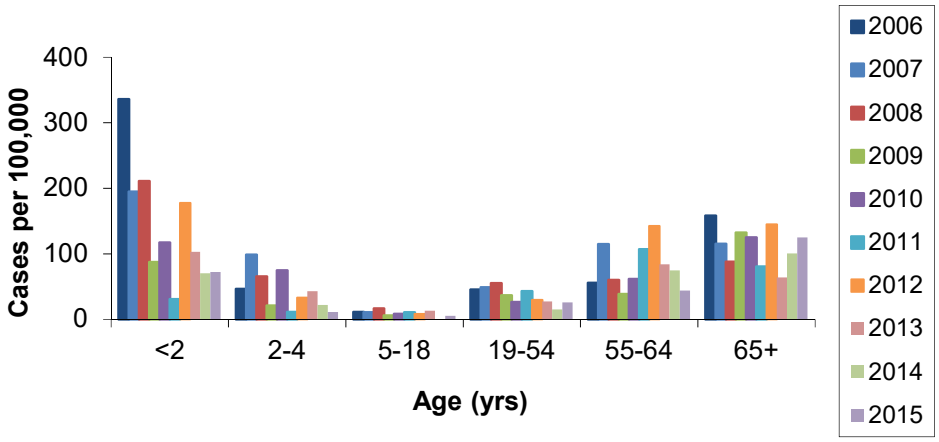
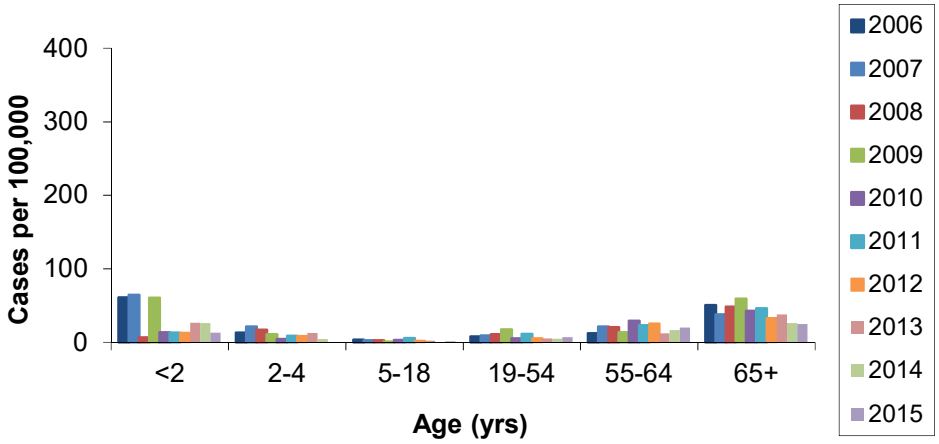


Figure 7: Invasive Pneumococcal Disease in Non-Natives, by Age Group - Alaska, 2006-2015

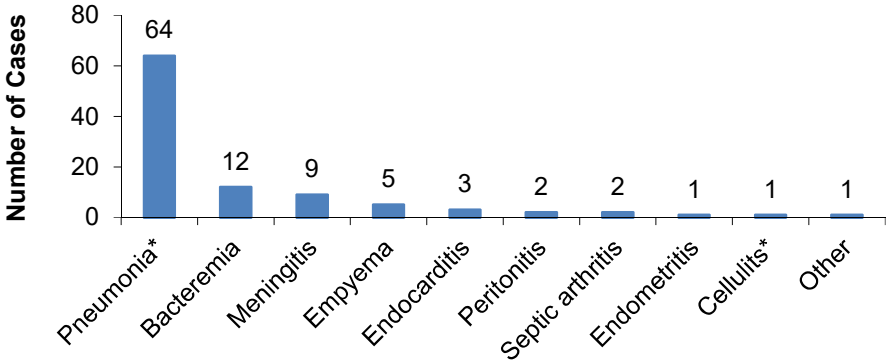


Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with

multiple discharge diagnoses, the most serious diagnosis related to the pneumococcal infection was recorded as the primary clinical presentation. Pneumonia with bacteremia was the most common primary clinical presentation in 2015 (64%) followed by bacteremia (12%). Twelve cases had a secondary pneumococcal-related diagnosis in 2015; eight were pneumonia with bacteremia, one each were empyema, osteomyelitis and streptococcal toxic shock syndrome and one case had septic arthritis and necrotizing fasciitis.

Figure 8: Primary Clinical Presentations of Invasive Pneumococcal Disease - Alaska, 2015



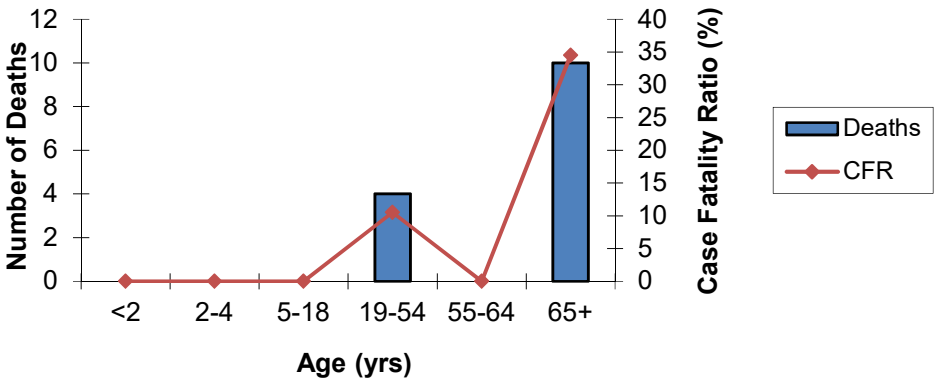
*with bacteremia

In 2015, blood was the most common source of a positive culture which was used to identify 93 (93%) of 100 cases. Two cases were identified from peritoneal fluid, two from cerebrospinal fluid, two from pleural fluid and one from a surgical aspirate.

Mortality

In 2015, the overall case fatality ratio for *S. pneumoniae* in Alaska was 14% (14 deaths out of 98 cases for which outcome was known). The case fatality ratio for AK Natives was slightly higher (16%, 7 deaths) than non-Natives (13%, 7 deaths). The largest number of deaths and highest case fatality ratio occurred in the 65 and older age category: 10 deaths, CFR 34.5%.

Figure 9: Invasive Pneumococcal Deaths & Case Fatality Ratios by Age Group - Alaska, 2015



Serotype

Serotyping of invasive pneumococcal isolates is performed at AIP using internationally standardized methods. Serotype identification is based on the organism's polysaccharide capsule which is a principal virulence factor for pneumococci. This information provides a way to categorize organisms and to determine if the infection was due to a type that could be prevented by use of one of the available pneumococcal vaccines. Serotyping was performed on all of the *S. pneumoniae* cases for which an isolate was available.

Table 3: Invasive Pneumococcal Serotype Distribution by Race and Age Group – Alaska, 2015

		Alaska Native					Non-Native				
Serotype	Total n (%)	<2	2-4	5-18	19-64	65+	<2	2-4	5-18	19-64	65+
03	12 (14)	1	-	1	3	2	-	-	1	3	1
06A	1 (1)	-	-	-	-	-	-	-	-	-	1
06C	2 (2)	-	-	-	-	-	-	-	-	1	1
07C	3 (3)	-	-	1	1	-	-	-	-	1	-
07F	3 (3)	-	-	-	2	-	-	-	-	1	-
08	3 (3)	-	-	-	-	1	-	-	-	2	-
09	1 (1)	-	-	-	1	-	-	-	-	-	-
09N	6 (7)	-	-	-	3	-	-	-	-	3	-
10A	4 (5)	-	-	-	1	-	-	-	-	3	-
11A	1 (1)	-	-	-	-	-	-	-	-	-	1
12F	1 (1)	-	-	-	-	-	-	-	-	1	-
15A	1 (1)	-	-	-	-	-	-	-	-	-	1
15B	2 (2)	-	-	-	1	-	-	-	-	1	-
15C	2 (2)	-	-	-	-	-	1	-	-	1	-
16F	7 (8)	-	-	-	2	2	-	-	-	3	-
17F	2 (2)	1	-	-	-	-	-	-	-	-	1
19A	1 (1)	-	1	-	-	-	-	-	-	1	-
19F	2 (2)	-	-	-	-	-	-	-	-	1	-
20	5 (6)	-	-	-	2	2	-	-	-	-	1
21	2 (2)	-	-	-	1	1	-	-	-	-	-
22F	8 (9)	-	-	-	3	1	-	-	-	4	-
23A	4 (5)	-	-	-	-	1	-	-	-	1	2
23B	1 (1)	-	-	-	-	1	-	-	-	-	-
28A	2 (2)	-	-	-	-	-	-	-	-	-	2
31	3 (4)	-	-	-	-	1	-	-	-	-	2
33F	5 (6)	1	-	-	-	1	1	-	-	2	-
34	1 (1)	-	-	-	1	-	-	-	-	-	-
35	1 (1)	-	-	-	-	-	-	-	-	-	1
35B	2 (2)	1	-	-	-	-	-	-	-	1	-
NT	1 (1)	-	-	-	1	-	-	-	-	-	-
Total	89	4	1	2	22	13	2	0	1	30	14

In 2015, the most common pneumococcal serotypes were 3, (12 isolates, 14%), 22F (8 isolates, 9%), 16F (7 isolates, 8%) and 9N (6 isolates, 7%). From 1986 through 2001, serotype 14 was the most common invasive pneumococcal serotype ranging from 7.4% to 23.5% of isolates. Following introduction in 2001 of the pneumococcal conjugate vaccine which includes serotype 14, the proportion of serotype 14 isolates dropped to 1.5% of serotyped isolates in 2006 and there were no serotype 14 cases in 2015. Disease caused by serotypes 7F and 19A, which are not included in the 7-valent conjugate vaccine, continually increased until the introduction of the 13-valent vaccine in 2010 which does include these two serotypes. Although cases caused by 7F and 19A continue to occur, they are no longer the most common serotypes and it is anticipated

that the number of cases will continue to decline with the use of the vaccine. The majority (42%) of serotype 3 cases, serotype 16F cases (86%) and serotype 22F cases (88%) occurred in the Anchorage area in 2015.

Table 4: Invasive Pneumococcal Serotype Distribution by Region – Alaska, 2015

Serotype	Anchorage	Arctic Slope	Bristol Bay	Interior	Kotzebue	Norton Sound	Southeast	YK Delta
03	5	-	-	3	-	-	1	3
06A	-	-	-	1	-	-	-	-
06C	1	-	-	-	-	1	-	-
07C	2	-	-	-	-	-	-	1
07F	1	-	-	-	-	-	2	-
08	2	-	-	-	-	-	-	1
09	-	-	-	-	-	-	-	1
09N	3	-	-	2	-	-	1	-
10A	3	-	-	-	-	-	-	1
11A	-	-	-	1	-	-	-	-
12F	1	-	-	-	-	-	-	-
15A	1	-	-	-	-	-	-	-
15B	1	-	-	-	1	-	-	-
15C	2	-	-	-	-	-	-	-
16F	6	-	-	-	-	-	-	1
17F	1	-	-	-	-	-	-	1
19A	1	-	-	-	-	-	-	-
19F	2	-	-	-	-	-	-	-
20	2	-	-	1	-	-	-	2
21	-	-	-	-	1	-	-	1
22F	7	-	-	1	-	-	-	-
23A	3	-	-	-	-	-	1	-
23B	-	-	-	1	-	-	-	-
28A	2	-	-	-	-	-	-	-
31	-	-	-	2	-	-	1	-
33F	2	-	-	-	1	-	-	2
34	1	-	-	-	-	-	-	-
35	1	-	-	-	-	-	-	-
35B	1	-	-	-	-	-	-	1
NT	-	-	1	-	-	-	-	-
Unknown	9	-	-	-	1	1	1	-
Total	59	0	1	12	4	2	7	15

Vaccine Serotypes

In 2001, the pneumococcal conjugate vaccine (PCV7) was included in the Alaska childhood vaccination schedule. This vaccine provided protection against the 7 most common pneumococcal serotypes causing invasive disease among children (types 4, 6B, 9V, 14, 18C, 19F, 23F). In early 2010, a new pneumococcal conjugate vaccine (PCV13) was introduced into

the Alaska childhood vaccination schedule. This vaccine provided protection against the 7 pneumococcal serotypes contained in the PCV7 vaccine plus six additional serotypes (1, 3, 5, 6A, 7F, 19A) that have caused invasive disease since the introduction of the PCV7 vaccine. The table below shows the proportion of invasive infections from 2015 that were due to serotypes found in the PCV13 vaccine. There were two cases of pneumococcal disease caused by serotypes contained in the PCV13 vaccine in children less than 5 years of age, the age group for which the vaccine is recommended.

Table 5: Proportion of Invasive Isolates Contained in the PCV13 Vaccine by Age Group and Race – Alaska, 2015

Age (yrs)	Alaska Native (%)	Non-Native (%)	Total (%)
<2	1 (25%) of 4	0 (0%) of 2	1 (17%) of 6
2-4	1 (100%) of 1	0 (0%) of 0	1 (100%) of 1
5+	8 (22%) of 37	9 (20%) of 45	17 (21%) of 82
Total	10 (24%) of 42	9 (19%) of 47	19 (21%) of 89

For the year covered by this report, the 23-valent polysaccharide vaccine (Ps23V) was recommended in Alaska for all persons 65 years and older, and for persons over age 2 who are at higher risk for pneumococcal disease [5]. In addition, one dose of PCV13 was also recommended for persons 65 years and older. In 2015, for persons 65 years and older, 11 (41%) of 27 cases serotyped were potentially vaccine preventable invasive pneumococcal illnesses.

Vaccine Failures

In 2015, pneumococcal vaccine status was known for 93 (93%) of the 100 cases; 42% (n=39) of cases with known vaccine status did receive a pneumococcal vaccine prior to illness and 54 cases (58%) had no record of a pneumococcal vaccine.

A PCV13 vaccine failure is defined as invasive pneumococcal disease caused by a serotype contained in the PCV13 vaccine in a child less than five years old who has had at least two doses of vaccine. There were two vaccine failures in 2015; both had received 4 doses of PCV13. One case had possible underlying immunodeficiencies and the second case had no risk factors reported; case serotypes were 3 and 19F, respectively.

Potentially Preventable Deaths

Overall, 43% of all pneumococcal-related mortality in 2015 was potentially preventable with the use of the 23-valent polysaccharide vaccine in persons over 5 years old; 43% of deaths were due to disease caused by serotypes not contained in pneumococcal vaccines.

Table 6: Potentially Vaccine Preventable Invasive Pneumococcal Deaths – Alaska, 2015

Serotypes	< 2 years	2-4	5-18	19-54	55-64	65+	Total
PCV13	0	0	0	1 (25%)	0	1 (10%)	2 (14%)
Ps23V	0	0	0	1 (25%)	0	5* (50%)	6 (43%)
Non-Vaccine	0	0	0	2 (50%)	0	4 (40%)	6 (43%)
Unknown	0	0	0	0	0	0	0
Total	0	0	0	4	0	10	14

*Two cases were serotype 3 which is also contained in PCV13

Six of the 14 deaths in 2015 from invasive *S. pneumoniae* occurred from serotypes contained within the Ps23V vaccine; five of the deaths were in individuals eligible for the vaccine. Two deaths occurred in a vaccinated individual; time since vaccination was 7 years for one case and 10 years for the second.

Table 7: Invasive Pneumococcal Disease, Serotypes of Fatal Cases – Alaska, 2015

Serotype	Deaths n (%)	Serotype Frequency (n)
03†*	3 (25%)	12
06A†	1 (100%)	1
11A*	1 (100%)	1
15B*	1 (50%)	2
15C	1 (50%)	2
16F	1 (14%)	7
20*	1 (20%)	5
21	1 (50%)	2
22F*	1 (14%)	7
23B	1 (100%)	1
31	1 (33%)	3
34	1 (100%)	1

†Serotypes contained in the 13-valent conjugate vaccine
*Serotypes contained in the 23-valent polysaccharide vaccine

Associated Risk Factors

The presence of one or more associated risk factors was reported in 73% of invasive pneumococcal cases in 2015. Chronic lung disease was the most prevalent risk factor observed in adults followed by cigarette smoking, diabetes and alcohol abuse.

Table 8: Associated Risk Factors Identified in Invasive Pneumococcal Cases – Alaska, 2015*

Risk Factor	Adult Cases (≥ 18 years) n=90, Cases (%)
Chronic lung disease	23 (26%)
Cigarette smoking	22 (24%)
Diabetes	19 (21%)
Alcohol abuse	18 (20%)
Immunosuppressive treatment	9 (10%)
Injection drug use	2 (2%)
Asplenia	0 (0%)

*More than one risk factor was identified in several cases

Antibiotic Resistance

Susceptibility testing was performed on 89 isolates received in 2015. Results of the testing are presented in the following table.

Table 9: Antibiotic Resistance in Invasive *Streptococcus pneumoniae* Isolates – Alaska, 2015

Antibiotic	Susceptible	Intermediate	Resistant	I + R	Total Tested
Penicillin	76 (85%)	10 (11%)	3 (3%)	13 (14%)	89
TMP-sulfa	84 (94%)	3 (3%)	2 (2%)	5 (5%)	89
Erythromycin	70 (79%)	0 (0%)	19 (21%)	19 (21%)	89
Ceftriaxone	88 (99%)	1 (1%)	0 (0%)	1 (1%)	89
Tetracycline	82 (92%)	2 (2%)	5 (6%)	7 (8%)	89
Chloramphenicol	87 (98%)	0 (0%)	2 (2%)	2 (2%)	89
Vancomycin	89 (100%)	0 (0%)	0 (0%)	0 (0%)	89
Levofloxacin	89 (100%)	0 (0%)	0 (0%)	0 (0%)	89
Clindamycin	85 (96%)	1 (1%)	3 (3%)	4 (4%)	89

Cut points from the Minimum Inhibitory Concentration (MIC) Interpretive Standards were used to determine if an isolate was 'susceptible', 'intermediate', or 'resistant' to the antibiotic being tested [7]. The MIC Interpretive Standards definitions of 'susceptible', 'intermediate', and 'resistant' can be found in the Appendix.

Serotypes found in the PCV7 and PCV13 vaccines are more likely to be non-susceptible to penicillin and erythromycin than non-vaccine serotypes. One potential benefit of the use of these vaccines was an anticipated decline in antibiotic resistance among circulating pneumococci. Following the initiation of the PCV7 vaccine in 2001, antibiotic resistance among invasive pneumococci dropped. During 2003, TMP-sulfa and penicillin resistance increased, however, following an increase in disease caused by serotype 19A. This serotype is included in the PCV13 vaccine; decreasing proportions of isolates resistant to most antibiotics tested may be due to the introduction of the vaccine. However, the proportion of isolates resistant to erythromycin has increased which is a trend that was also seen after the introduction of PCV7 [8].

Figure 10: Trends in Antibiotic Non-Susceptibility Among Invasive Pneumococcal Isolates - Alaska, 1995 - 2015

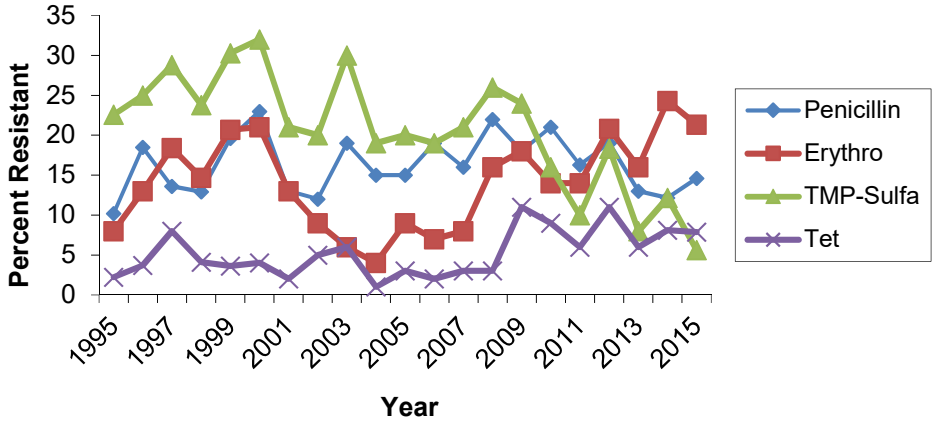


Table 10: Summary of Invasive *Streptococcus pneumoniae* Case Characteristics, Alaska, 2015

Sex	Age (Yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serotype*	Associated Risk Factors	Survived
M	0.6	AK Native	Other	Blood	Septic arthritis	35B	None	Yes
F	0.6	Unknown	Other	Blood	Pneumonia	33F	None	Yes
F	0.7	Non-Native	Anchorage	CSF	Meningitis	15C	None	Yes
F	0.9	AK Native	Other	Blood	Bacteremia	17F	None	Yes
M	1.8	AK Native	Other	Blood	Pneumonia	33F	None	Yes
F	1.9	AK Native	Other	Blood	Pneumonia	3	None	Yes
M	4.7	AK Native	Anchorage	Blood	Bacteremia	19F	None	Yes
F	5.5	AK Native	Other	Pleural fluid	Empyema, pneumonia	3	None	Yes
M	15.7	Non-Native	Anchorage	Blood	Pneumonia	3	None	Yes
M	17.5	AK Native	Other	Blood	Meningitis	7C	None	Yes
M	22.8	AK Native	Anchorage	Blood	Pneumonia	16F	None	Yes
M	23.4	AK Native	Other	Blood	Bacteremia	15B	Alcohol abuse	Yes
M	30	AK Native	Other	Blood	Bacteremia	9N	Alcohol abuse	Yes
F	33.5	Non-Native	Other	Blood	Bacteremia	6C	Diabetes	Yes
M	33.7	Non-Native	Anchorage	Blood	Pneumonia	8	Smoking	Yes
M	33.7	AK Native	Other	Blood	Pneumonia	NT	Alcohol abuse	Yes
M	35.8	Non-Native	Anchorage	Blood	Bacteremia	22F	Smoking, chronic lung disease	Yes
M	36.8	Non-Native	Other	Blood	Pneumonia	ND	Smoking	Yes
F	37.2	AK Native	Other	Blood	Pneumonia	22F	Smoking	Yes
M	42.7	Non-Native	Anchorage	Blood	Pneumonia	ND	None	Yes
F	43.1	AK Native	Anchorage	Blood	Pneumonia	22F	Smoking, alcohol abuse, diabetes	Yes
M	43.7	Non-Native	Anchorage	Blood	Pneumonia	12F	Injection drug use	Yes
M	44.6	AK Native	Anchorage	Blood	Meningitis, empyema	3	Smoking, diabetes	Yes
M	44.7	AK Native	Anchorage	Blood	Pneumonia	20	None	Yes
M	44.8	AK Native	Anchorage	Blood	Endocarditis, pneumonia	9N	Alcohol abuse	Yes
M	45	AK Native	Other	Blood	Pneumonia	3	None	Yes
M	45.3	Non-Native	Anchorage	Blood	Pneumonia	9N	None	Yes
M	46.6	AK Native	Other	Blood	Pneumonia	20	Smoking	Yes
F	46.7	Non-Native	Anchorage	Blood	Endometritis	3	None	Yes
F	48.7	AK Native	Other	Blood	Pneumonia	7F	Smoking, chronic lung disease	Yes
F	49.2	AK Native	Anchorage	Blood	Pneumonia	9N	None	Yes
M	49.2	Non-Native	Anchorage	Blood	Pneumonia	15B	Smoking, chronic lung disease, immune suppressive therapy	No
M	49.5	AK Native	Anchorage	Blood	Meningitis	34	Smoking, alcohol abuse	No
F	49.8	AK Native	Other	Blood	Pneumonia	7F	None	Yes
M	49.9	Non-Native	Anchorage	Blood	Pneumonia	7C	Smoking, chronic lung disease, alcohol abuse, immune suppressive therapy	Yes
M	49.9	Non-Native	Anchorage	Blood	Pneumonia	8	None	Yes
M	50.8	Non-Native	Anchorage	Blood	Pneumonia	ND	Smoking, immune suppressive therapy	Yes
F	51.1	Non-Native	Anchorage	Blood	Septic arthritis, osteomyelitis	10A	None	Yes
M	52.6	Non-Native	Anchorage	Blood	Pneumonia	19F	None	Yes

Sex	Age (Yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serotype*	Associated Risk Factors	Survived
M	52.6	Non-Native	Other	Blood	Bacteremia	9N	None	Yes
M	52.9	Non-Native	Anchorage	Peritoneal fluid	Peritonitis, pneumonia	7F	Alcohol abuse	Yes
F	53	Non-Native	Anchorage	Blood	Pneumonia	33F	Smoking	Yes
F	54	Non-Native	Anchorage	Blood	Pneumonia	3	None	No
F	54	Non-Native	Anchorage	Blood	Meningitis	22F	None	Yes
M	54.6	Non-Native	Anchorage	Peritoneal fluid	Peritonitis	15C	Diabetes	No
M	54.7	AK Native	Other	Blood	Pneumonia	9	Smoking, alcohol abuse	Yes
M	54.9	AK Native	Other	Blood	Pneumonia	16F	None	Yes
M	54.9	Non-Native	Anchorage	Blood	Pneumonia	16F	Alcohol abuse	Yes
M	57.3	AK Native	Anchorage	Blood	Endocarditis	22F	Diabetes	Yes
F	57.8	Unknown	Anchorage	Blood	Pneumonia	ND	Smoking	Yes
M	58.1	Non-Native	Anchorage	Blood	Empyema, pneumonia	35B	Smoking	Yes
F	58.5	AK Native	Other	Blood	Pneumonia	21	Smoking, chronic lung disease	Yes
M	58.8	Non-Native	Anchorage	Blood	Pneumonia	16F	Chronic lung disease, immune suppressive therapy	Yes
M	59	Non-Native	Anchorage	Blood	Pneumonia	22F	Immune suppressive therapy	Yes
M	59	AK Native	Other	Blood	Empyema, pneumonia	3	Alcohol abuse	Yes
M	59	Non-Native	Anchorage	Blood	Pneumonia, strep toxic shock	23A	Alcohol abuse	Yes
M	59.7	AK Native	Anchorage	Blood	Pneumonia	7C	Alcohol abuse	Yes
F	59.7	AK Native	Other	Blood	Pneumonia	10A	Chronic lung disease, alcohol abuse, diabetes	Yes
M	60.2	Non-Native	Anchorage	Blood	Pneumonia	19A	Alcohol abuse, injection drug use	Yes
F	60.2	Non-Native	Anchorage	Blood	Pneumonia	ND	None	Yes
F	60.9	AK Native	Other	Surgical aspirate	Other	ND	Alcohol abuse, diabetes	Yes
F	61	Non-Native	Anchorage	CSF	Meningitis	ND	Diabetes	Yes
M	62	Non-Native	Anchorage	Blood	Bacteremia	33F	Smoking, alcohol abuse, diabetes	Yes
F	62.1	Non-Native	Other	Blood	Pneumonia	9N	Chronic lung disease	Yes
F	62.1	Non-Native	Anchorage	Blood	Pneumonia	16F	Chronic lung disease	Yes
F	62.2	Unknown	Anchorage	Blood	Meningitis	22F	Diabetes	Yes
M	62.4	Non-Native	Anchorage	Blood	Pneumonia	10A	Smoking, alcohol abuse	Yes
F	62.9	Non-Native	Anchorage	Blood	Meningitis, septic arthritis, necrotizing fasciitis	10A	Diabetes	Yes
M	64.4	Unknown	Anchorage	Blood	Bacteremia	ND	Unknown	Unknown
M	64.5	Non-Native	Other	Blood	Pneumonia	ND	None	Unknown
F	64.7	Non-Native	Other	Blood	Pneumonia	3	Chronic lung disease	Yes
M	65.5	Non-Native	Anchorage	Blood	Pneumonia	ND	None	Yes
M	65.5	Unknown	Anchorage	Blood	Pneumonia	ND	None	Yes
F	67.1	AK Native	Other	Blood	Pneumonia	20	Chronic lung disease, immune suppressive therapy, diabetes	Yes
M	67.6	AK Native	Other	Blood	Pneumonia	20	None	Yes
M	69.8	Non-Native	Anchorage	Blood	Pneumonia	15A	None	Yes

Sex	Age (Yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serotype*	Associated Risk Factors	Survived
M	70.2	Non-Native	Anchorage	Blood	Bacteremia	20	Smoking	No
M	70.9	AK Native	Other	Blood	Pneumonia	31	Smoking, diabetes	Yes
F	72.6	AK Native	Other	Blood	Pneumonia	3	Diabetes	No
M	73.6	Non-Native	Anchorage	Blood	Pneumonia	28A	Chronic lung disease	Yes
M	73.7	Non-Native	Other	Blood	Pneumonia	11A	Chronic lung disease	No
F	74.2	Non-Native	Anchorage	Blood	Endocarditis, pneumonia	23A	None	Yes
M	74.8	Unknown	Other	Blood	Pneumonia	31	None	No
M	74.9	Non-Native	Anchorage	Blood	Meningitis	3	Smoking, chronic lung disease, diabetes	Yes
M	77.1	AK Native	Other	Blood	Bacteremia	23A	Chronic lung disease	Yes
F	80.9	AK Native	Other	Blood	Pneumonia	33F	None	Yes
M	81.4	Non-Native	Other	Blood	Pneumonia	31	Chronic lung disease	Yes
M	81.8	Non-Native	Other	Blood	Pneumonia	6A	Diabetes	No
M	82.9	Non-Native	Anchorage	Blood	Cellulitis	17F	None	Yes
F	83.3	AK Native	Other	Blood	Pneumonia	3	Chronic lung disease	No
M	83.3	Non-Native	Anchorage	Blood	Pneumonia	6C	Chronic lung disease, immune suppressive thereapy	Yes
F	84.4	Non-Native	Anchorage	Blood	Pneumonia	35	Diabetes	Yes
F	84.7	AK Native	Anchorage	Pleural fluid	Pneumonia	16F	Chronic lung disease, immune suppressive therapy	No
F	84.7	AK Native	Other	Blood	Bacteremia	23B	Chronic lung disease, diabetes	No
M	86	AK Native	Anchorage	Blood	Empyema, pneumonia	16F	Chronic lung disease	Yes
F	86.1	Non-Native	Anchorage	Blood	Pneumonia	28A	Chronic lung disease	Yes
M	87.2	AK Native	Other	Blood	Pneumonia	21	Chronic lung disease, immune suppressive therapy, diabetes	No
M	94.1	AK Native	Anchorage	Blood	Pneumonia	22F	None	No
M	94.6	Non-Native	Anchorage	Blood	Empyema, pneumonia	23A	None	Yes

*ND = typing not done
NT = non-typeable

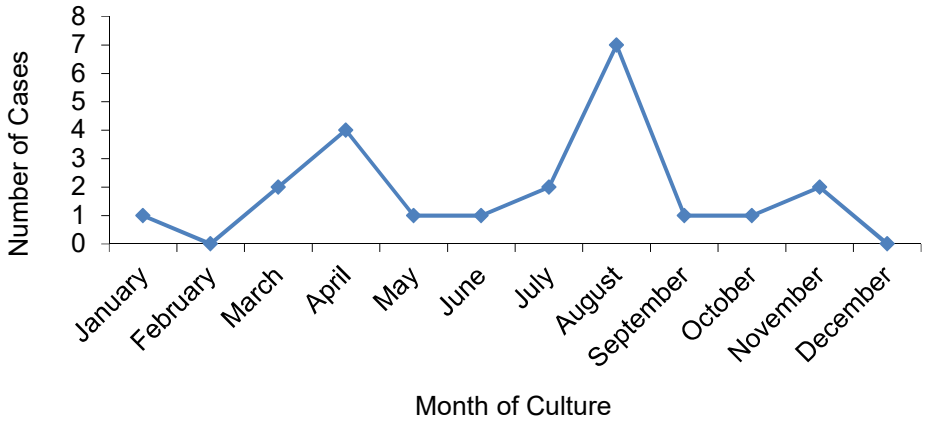
Invasive *Haemophilus influenzae*

Overall Incidence

In 2015, there were 22 cases of invasive *Haemophilus influenzae* in Alaska, for a statewide rate of 3/100,000 persons per year. This rate is higher than the ABCs national projected rate of 1.9/100,000 persons per year [9]. There were no deaths associated with *H. influenzae* in 2015.

Seasonality

Figure 11: *Haemophilus influenzae* Disease by Month of Culture - Alaska, 2015

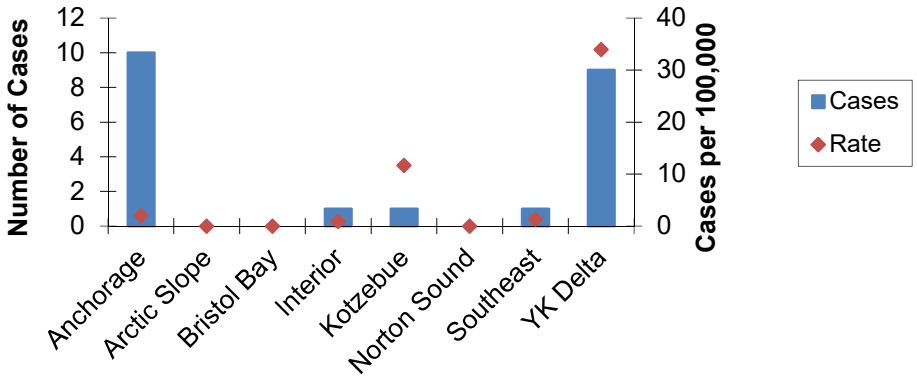


Cases of invasive *H. influenzae* occurred throughout 2015; however, due to the small number of cases, trends in seasonality cannot be determined. The largest number of cases (n=7) occurred in August.

Region

The highest rates of disease caused by invasive *H. influenzae* cases in 2015 were in the YK Delta region, 33.9/100,000 (9 cases), and the Kotzebue region, 11.7/100,000 (1 case). Although a large number of cases occurred in the Anchorage area (10 cases), the rate was much lower (2/100,000).

Figure 12: Invasive *Haemophilus influenzae*, Cases & Rates by Region - Alaska, 2015



Race

Table 11: Invasive *Haemophilus influenzae* Cases by Race – Alaska, 2015

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	10 (45%)	6.2	70%	0 (0%)
Non-Native	12 (55%)	1.7	25%	0 (0%)
Total	22		45%	0 (0%)

*Cases per 100,000 per percent distribution of Alaska 2010 population

In 2015, 45% of the cases occurred in Alaska Natives. Age-adjusted rates were calculated for Alaska Natives and non-Natives. The age-adjusted rate ratio of *H. influenzae* disease for the Alaska Native population compared with the non-Native population in 2015 was 3.6.

Age

H. influenzae cases ranged in age from 4 months to 87 years of age in 2015 (median 40.7 years). Overall, the highest rates of disease occurred in children less than 2 years old (18.9/100,000).

Rates of disease in Alaska Native versus non-Native populations by age group were variable; overall numbers of cases and rates by race and age group are presented in Figure 14. The highest rates of disease occurred in Alaska Native children less than two years of age and 2-4 years of age, 71.9/100,000 persons per year and 32.6/100,000 persons per year, respectively.

Figure 13: Invasive *Haemophilus influenzae* by Age Group - Alaska, 2015

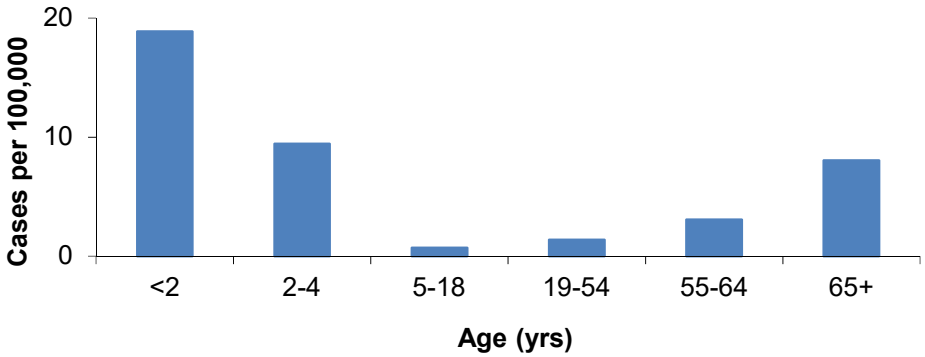
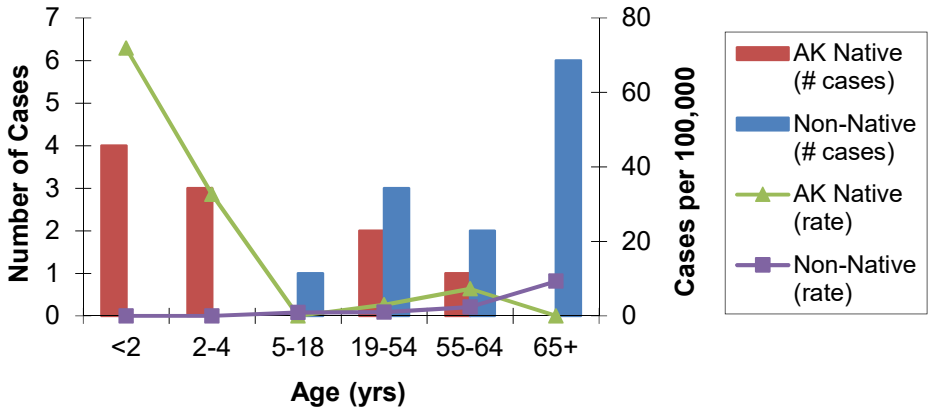


Figure 14: Invasive *Haemophilus influenzae*, Cases & Rates by Age Group & Race - Alaska, 2015



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. For cases with more than one diagnosis, the most serious *H. influenzae*-related diagnosis was recorded as the primary clinical presentation. In 2015, pneumonia with bacteremia was the most common presentation (55% of cases).

Eighteen (82%) *H. influenzae* isolates were from blood samples in 2015, and one each was from cerebrospinal fluid, pleural fluid, peritoneal fluid and a surgical aspirate.

Table 12: Primary Clinical Presentation of Invasive *Haemophilus influenzae* - Alaska, 2015

Primary Presentation	n (%)
Pneumonia*	12 (55%)
Bacteremia	2 (9%)
Meningitis	2 (9%)
Septic arthritis	2 (9%)
Empyema	1 (5%)
Peritonitis	1 (5%)
Cellulitis*	1 (5%)
Other	1 (5%)
Total	22

*with bacteremia

Serotypes

All isolates received at AIP are serotyped; 21 cases in 2015 had isolates and were serotyped. The bacterial capsule is the basis for serotyping and is the primary virulence factor. Serotype b was the most common serotype in the past, but its prevalence has decreased with use of the childhood Hib vaccine. Surveillance of serotypes is important for monitoring vaccine effectiveness and emergence of non-vaccine serotypes.

Table 13: Serotypes of Invasive *Haemophilus influenzae* Cases by Race – Alaska, 2015

		Alaska Native				Non-Native			
Serotype	Total n (%)	<2	2-18	19-64	65+	<2	2-18	19-64	65+
a	6 (29%)	3	2	1	-	-	-	-	-
b	1 (4.5%)	-	1	-	-	-	-	-	-
e	1 (4.5%)	-	-	-	-	-	-	-	1
NT*	13 (62%)	1	-	2	-	-	1	4	5
Total	21	4	3	3	0	0	1	4	6

*Non-typeable

Hib

In recent years, the prevalence of *H. influenzae* type b has declined due to increased use of a childhood vaccine against this serotype. There was one case of Hib in a child less than 5 years old in 2015; the child was fully vaccinated.

Hia

Prior to 2002, *H. influenzae* type a (Hia) had not been detected in Alaska. Following an outbreak in 2003 [10], cases have occurred sporadically until 2010 when an outbreak began in the YK Delta and continued through 2011 [11]. Six cases of Hia were detected in 2015; all occurred in AK Native people. The rate of invasive disease caused by Hia in AK Native children less than 2 years old for 2015 was 53.9/100,000.

Antibiotic Resistance

Twenty-two *H. influenzae* isolates received at AIP were tested for susceptibility to ampicillin, chloramphenicol, ceftriaxone and TMP/sulfa. All isolates tested were susceptible to ceftriaxone, 4 isolates were resistant to ampicillin (1 intermediate, 3 fully resistant), 13 isolates were resistant to TMP/sulfa (4 intermediate and 9 fully resistant) and one isolate showed intermediate resistance to chloramphenicol.

Table 14: Summary of Invasive *Haemophilus influenzae* Case Characteristics, Alaska, 2015

Sex	Age (Yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serotype*	Associated Risk Factors	Survived
M	0.3	AK Native	Other	Blood	Meningitis	a	None	Yes
M	0.5	AK Native	Other	CSF	Meningitis	a	None	Yes
F	1.2	AK Native	Other	Blood	Pneumonia	NT	None	Yes
M	1.8	AK Native	Other	Blood	Septic arthritis	a	Chronic lung disease	Yes
M	2	AK Native	Other	Surgical aspirate	Septic arthritis	a	None	Yes
M	3.5	AK Native	Other	Blood	Pneumonia	b	None	Yes
F	3.5	AK Native	Other	Blood	Cellulitis	a	None	Yes
F	7.2	Non-Native	Anchorage	Blood	Pneumonia	NT	Chronic lung disease	Yes
F	22.8	Non-Native	Anchorage	Peritoneal fluid	Peritonitis	NT	Chronic lung disease	Yes
M	34.2	AK Native	Other	Blood	Pneumonia	NT	Smoking, alcohol abuse	Yes
F	34.7	Non-Native	Anchorage	Blood	Pneumonia	NT	None	Yes
F	46.7	Non-Native	Other	Blood	Other	NT	None	Yes
F	52.7	AK Native	Other	Blood	Pneumonia	NT	Smoking, alcohol abuse	Yes
M	60	AK Native	Other	Blood	Bacteremia	a	None	Yes
M	62	Non-Native	Anchorage	Pleural fluid	Empyema, pneumonia	ND	Smoking, chronic lung disease	Yes
F	64.6	Non-Native	Anchorage	Blood	Pneumonia	NT	Chronic lung disease	Yes
F	71.3	Non-Native	Anchorage	Blood	Pneumonia	NT	Chronic lung disease	Yes
F	76	Non-Native	Other	Blood	Pneumonia	e	Immune suppressive therapy, diabetes	Yes
F	78.8	Non-Native	Anchorage	Blood	Pneumonia	NT	Immune suppressive therapy, diabetes	Yes
M	83.5	Non-Native	Anchorage	Blood	Pneumonia	NT	Chronic lung disease	Yes
F	85.1	Non-Native	Anchorage	Blood	Pneumonia	NT	None	Yes
M	86.9	Non-Native	Anchorage	Blood	Pneumonia	NT	Immune suppressive therapy	Yes

*NT = non-typeable
ND = typing not done

Invasive *Neisseria meningitidis*

Overall Incidence

Four cases of invasive *Neisseria meningitidis* were reported to AIP in 2015 for an overall rate of 0.5/100,000. The Alaska rate is slightly higher than the ABCs 2015 national projected rate of 0.11/100,000 [12]. There were no invasive *N. meningitidis*-related deaths in Alaska in 2015.

Race

Table 15: Invasive *Neisseria meningitidis* Cases by Race – Alaska, 2015

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	1 (25%)	0.8	100%	0 (0%)
Non-Native	3 (75%)	0.5	0%	0 (0%)
Total	4		67%	0 (0%)

*Cases per 100,000 per percent distribution of Alaska 2010 population

In 2015, 25% of the cases occurred in Alaska Natives. Age-adjusted rates were calculated for Alaska Natives and non-Natives. The age-adjusted rate ratio of *N. meningitidis* disease for the Alaska Native population compared with the non-Native population in 2015 was 1.6.

Table 16: Summary of Invasive *Neisseria meningitidis* Case Characteristics, Alaska, 2015

Sex	Age (Yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serogroup	Associated Risk Factors	Survived
F	13.4	Non-Native	Other	Blood	Meningitis	C	None	Yes
F	24.9	Non-Native	Other	CSF	Meningitis	C	Smoking	Yes
F	27.3	AK Native	Anchorage	Blood	Bacteremia	C	None	Yes
M	37.3	Non-Native	Anchorage	Blood	Meningitis	C	Smoking, alcohol abuse	Yes

Invasive group A *Streptococcus*

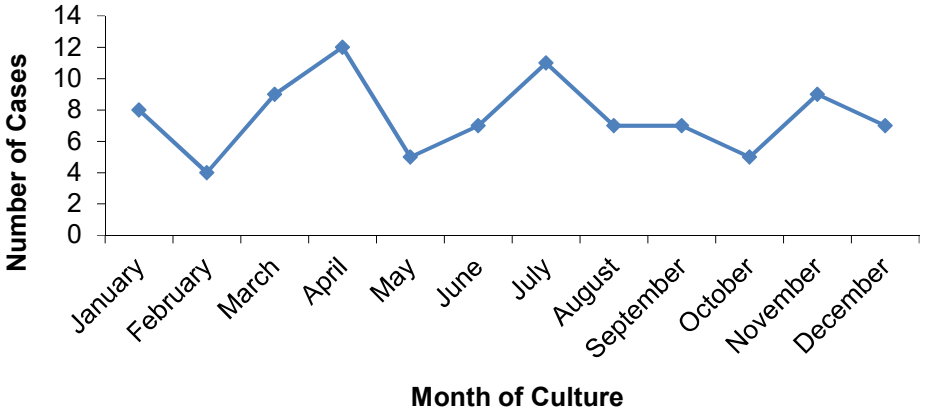
Overall Incidence

A total of 91 cases of invasive group A *Streptococcus* (GAS) were reported to AIP in 2015. The overall rate of invasive GAS disease in the state of Alaska was 12.3/100,000 persons per year. The Alaska rate is higher than the ABCs 2015 national projected rate of 4.8/100,000 [13]. In 2015, there were 10 GAS-related deaths for a case fatality ratio of 11%.

Seasonality

Cases of group A *Streptococcus* occurred throughout the year in 2015 with no apparent trends in seasonality. The largest number of cases (n=12) occurred in April.

Figure 15: Invasive group A *Streptococcus*, by Month of Culture - Alaska, 2015



Race

In 2015, 41% of invasive GAS cases in Alaska occurred in the Alaska Native population. The age-adjusted rate ratio of invasive GAS disease for the Alaska Native population compared with the non-Native population in 2015 was 3.3.

Table 17: Invasive group A *Streptococcus* Cases by Race – Alaska, 2015

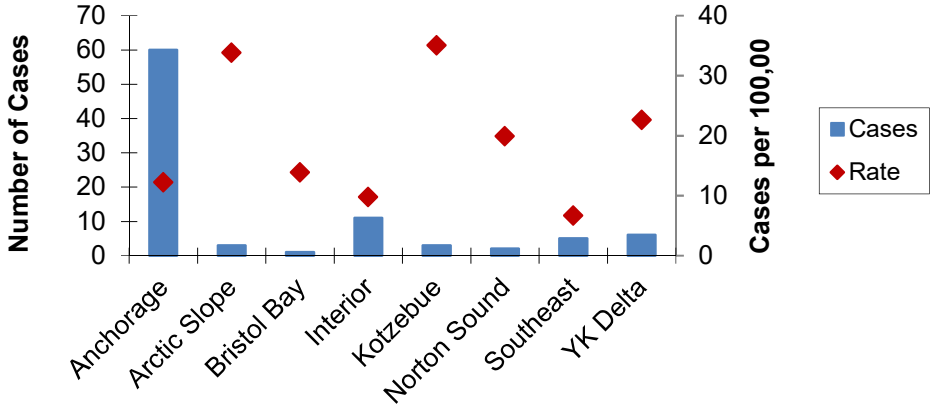
Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	37 (41%)	28	54%	3 (8%)
Non-Native	54† (59%)	8.5	63%	7 (13%)
Total	91		59%	10 (11%)

*Cases per 100,000 per percent distribution of Alaska 2010 population
†Includes 5 cases for which race is unknown

Region

Sixty (66%) of the 91 invasive group A *Streptococcus* cases in 2015 were reported in the Anchorage area, 11 cases in the Interior, 6 cases in the YK Delta, 5 cases in the Southeast, 3 cases each in the Arctic Slope and Kotzebue, 2 cases in Norton Sound and 1 case in Bristol Bay. The highest rates of disease occurred in the Kotzebue region (35.1/100,000) and the Arctic Slope (33.9/100,000).

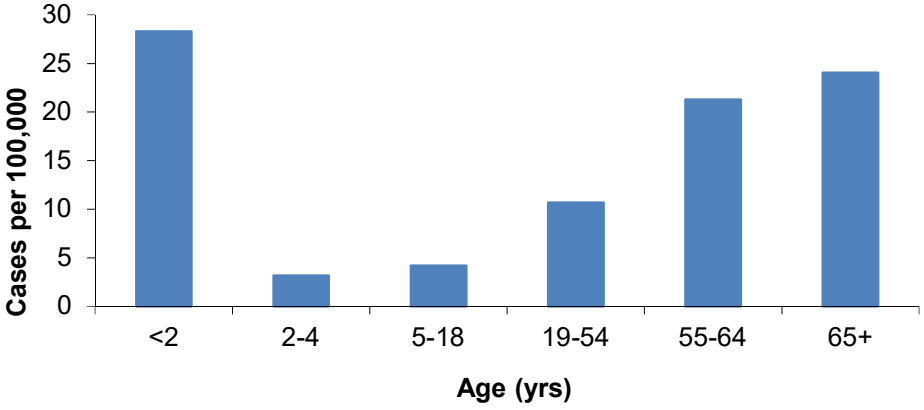
Figure 16: Invasive GAS Disease, Cases & Rates by Region - Alaska, 2015



Age

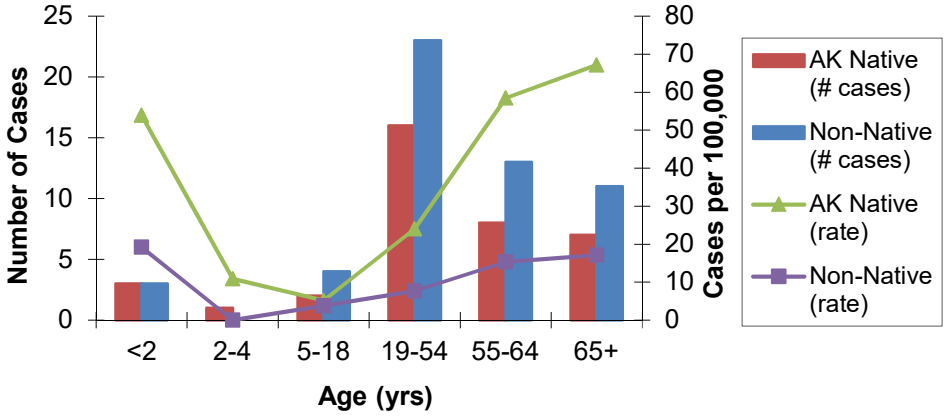
Invasive group A *Streptococcus* cases reported in 2015 ranged in age from 11 days to 95.3 years old; the median age was 51.7 years. Highest rates of disease occurred in children less than 2 years old (28.3/100,000).

Figure 17: Invasive group A *Streptococcus* by Age Group - Alaska, 2015



When stratified by race, the highest rates of invasive group A streptococcal disease occurred in Alaska Native adults 65 years and older (67.1/100,000 persons per year). The highest GAS disease rate in the non-Native population occurred in children less than two years old (19.2/100,000 persons per year).

Figure 18: Invasive group A *Streptococcus*, Cases & Rates by Age Group & Race - Alaska, 2015



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the GAS infection was recorded as the primary clinical presentation. Table 15 shows the primary clinical presentations of invasive group A *Streptococcus* in Alaska for 2015.

Group A *Streptococcus* was isolated from blood samples in 68 (75%) of 91 cases, 16 from tissue specimens, 2 each from joint fluid and aspirates, and one each from CSF, pleural fluid and bone.

Table 18: Primary Clinical Presentations of Invasive group A *Streptococcus* – Alaska, 2015

Primary Presentation	n (%)
Cellulitis*	32 (35%)
Bacteremia	18 (20%)
Pneumonia*	9 (10%)
Necrotizing fasciitis	8 (9%)
Osteomyelitis	7 (8%)
Septic arthritis	6 (7%)
Empyema	4 (4%)
Strep toxic shock	3 (3%)
Endocarditis	2 (2%)
Meningitis	1 (1%)
Other	1 (1%)
Total	91

*with bacteremia

Associated Risk Factors

The presence of one or more associated risk factors was reported in 80% of invasive GAS cases in 2015. Cigarette smoking was the most prevalent risk factor observed in adults followed by alcohol abuse and chronic lung disease.

Table 19: Associated Risk Factors Identified in Invasive GAS Cases – Alaska, 2015*

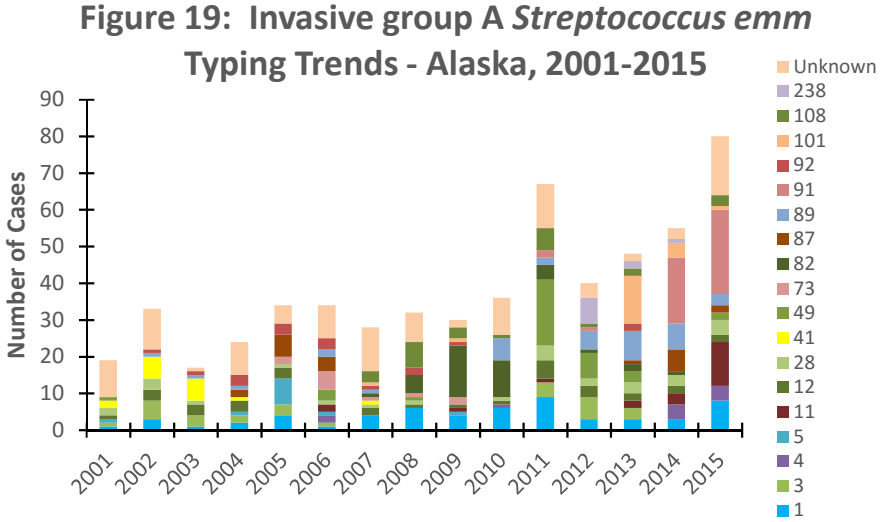
Medical Condition/Risk Factor	Adult Cases (≥ 18 years) n=80, Cases (%)
Cigarette smoking	27 (34%)
Alcohol abuse	24 (30%)
Chronic lung disease	23 (29%)
Diabetes	19 (24%)
Injection drug use	8 (10%)
Immunosuppressive treatment	5 (6%)
Asplenia	0 (0%)

*More than one risk factor was identified in several cases

Molecular Typing

Strain characterization of GAS has traditionally been based on serological identification of the M protein which is a major surface protein and an important GAS virulence factor. In the mid-1990s, many reference labs started using a molecular approach based on sequencing of the N-terminal region of the M protein gene (*emm* gene). To date, more than 200 different *emm* types have been reported. While there are currently no vaccines available to protect against invasive GAS disease, baseline data on the burden of GAS disease to include *emm* typing are critical to evaluate the potential utility of any candidate vaccines.

In 2015, 75 invasive GAS isolates were *emm* typed at AIP. The most common *emm* types were *emm* 91 (31%) and *emm* 11 (16%). The following graph shows *emm* typing trends over time. Strains that totaled ≤ 10 over the time period were not included.



Antibiotic Resistance

Seventy-five GAS isolates received at AIP were tested for susceptibility to penicillin, ceftriaxone, erythromycin, vancomycin, levofloxacin and clindamycin. All isolates tested were susceptible to penicillin, ceftriaxone, and vancomycin. Thirteen isolates were resistant to erythromycin; 12 of those were *emm* type 11 and one was *emm* type 22 which was also resistant to clindamycin. One isolate was resistant to levofloxacin; it was *emm* type 108.

Table 20: Summary of Invasive group A *Streptococcus* Case Characteristics, Alaska, 2015

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	*emm* Type*	Associated Risk Factors	Survived
F	11 days	Non-Native	Other	Blood	Bacteremia	12	None	Yes
M	1 month	Non-Native	Anchorage	Blood	Bacteremia	49	None	Yes
F	0.1	AK Native	Anchorage	Blood	Bacteremia	49	None	Yes
F	0.2	AK Native	Other	Blood	Cellulitis	ND	None	Yes
M	0.2	Unknown	Anchorage	Blood	Bacteremia	4	None	Yes
M	1.3	AK Native	Other	Blood	Bacteremia	34	None	Yes
F	2.2	AK Native	Other	Blood	Pneumonia	87	None	Yes
M	5.2	Non-Native	Anchorage	Blood	Bacteremia	28	None	Yes
F	6.2	AK Native	Anchorage	Tissue	Other	ND	None	Yes
M	11	AK Native	Anchorage	Blood	Cellulitis	1	None	Yes
M	15.6	Non-Native	Anchorage	Blood	Endocarditis, pneumonia	1	None	Yes
M	18.1	Non-Native	Anchorage	Blood	Cellulitis	4	None	Yes
F	18.8	Non-Native	Other	Blood	Bacteremia	1	None	Yes
F	24.2	Non-Native	Anchorage	Blood	Strep toxic shock	118	None	Yes
F	25.6	Non-Native	Anchorage	Pleural fluid	Pneumonia	4	Smoking, injection drug use	Yes
M	30	AK Native	Other	Tissue	Cellulitis	ND	Smoking	Yes
F	31	Unknown	Other	Blood	Empyema, pneumonia	6	Smoking, injection drug use	Yes
F	31.1	Non-Native	Anchorage	Blood	Bacteremia	28	None	Yes
M	31.3	Non-Native	Anchorage	Joint fluid	Septic arthritis	ND	Injection drug use	Yes
M	34	Non-Native	Anchorage	Joint fluid	Septic arthritis, cellulitis	ND	None	Yes
F	34.1	Non-Native	Other	Blood	Endocarditis	75	Smoking, injection drug use	Yes
M	35	Non-Native	Other	Tissue	Cellulitis	ND	None	Yes
F	36.9	Non-Native	Other	Blood	Empyema	28	None	Yes
M	40.1	AK Native	Anchorage	Tissue	Cellulitis	ND	Smoking	Yes
M	40.2	AK Native	Anchorage	Blood	Pneumonia, cellulitis	81	Smoking, injection drug use	Yes
M	40.7	AK Native	Anchorage	Tissue	Cellulitis	11	Smoking	Yes
F	41.3	Non-Native	Anchorage	Blood	Bacteremia	89	Smoking, chronic lung disease	Yes
M	42.2	AK Native	Other	Tissue	Cellulitis, necrotizing fasciitis	91	Smoking	Yes
F	42.3	AK Native	Other	Blood	Cellulitis, necrotizing fasciitis	91	Alcohol abuse	Yes
M	43.7	AK Native	Other	Aspirate	Cellulitis	91	Smoking, chronic lung disease, alcohol abuse, injection drug use	Yes
F	44.7	Non-Native	Other	Blood	Necrotizing fasciitis	12	Immune suppressive treatment, diabetes	Yes
F	44.9	AK Native	Other	Blood	Cellulitis	91	Immune suppressive treatment	Yes
M	45.2	AK Native	Other	Bone	Osteomyelitis	ND	Smoking	Yes
M	45.5	AK Native	Anchorage	Tissue	Cellulitis	91	Smoking, injection drug use	Yes
M	46.1	AK Native	Anchorage	Blood	Cellulitis	11	Alcohol abuse	Yes
M	48.3	AK Native	Other	Blood	Cellulitis	75	Alcohol abuse	Yes
M	48.4	Non-Native	Anchorage	Blood	Cellulitis	11	Chronic lung disease, alcohol abuse	Yes
M	49.2	AK Native	Other	Blood	Cellulitis	91	Smoking, chronic lung disease, alcohol abuse, diabetes	Yes
M	49.9	Non-Native	Anchorage	Blood	Cellulitis, necrotizing fasciitis	22	Smoking, immune suppressive treatment, injection drug use	Yes
F	50.2	AK Native	Anchorage	Blood	Cellulitis	11	Smoking, alcohol abuse	Yes
M	50.3	Non-Native	Anchorage	Blood	Septic arthritis, cellulitis, osteomyelitis	108	Smoking, chronic lung disease, diabetes	Yes
M	50.6	Non-Native	Anchorage	Blood	Osteomyelitis	108	Diabetes	Yes
M	51	Non-Native	Anchorage	Blood	Pneumonia	91	Smoking, chronic lung disease, diabetes	Yes
M	51.4	Non-Native	Anchorage	Blood	Cellulitis	1	None	Yes
M	51.6	AK Native	Other	Blood	Bacteremia	108	None	Yes
M	51.7	Non-Native	Anchorage	Blood	Bacteremia	91	None	No
M	52.3	AK Native	Anchorage	Blood	Bacteremia	91	Alcohol abuse	Yes

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	*emm* Type*	Associated Risk Factors	Survived
F	52.9	Non-Native	Anchorage	Tissue	Pneumonia, cellulitis	11	Smoking, chronic lung disease, diabetes	Yes
M	53	Non-Native	Anchorage	Blood	Cellulitis	ND	Smoking, diabetes	Yes
M	54	Non-Native	Anchorage	Blood	Cellulitis, necrotizing fasciitis	11	Alcohol abuse	No
M	54.1	Unknown	Anchorage	Blood	Pneumonia	ND	None	No
M	54.7	Non-Native	Other	Tissue	Cellulitis, necrotizing fasciitis	91	Diabetes	Yes
M	55	AK Native	Other	Tissue	Cellulitis, osteomyelitis	101	Smoking, diabetes	Yes
M	55.9	Non-Native	Anchorage	Blood	Septic arthritis, cellulitis	91	Alcohol abuse	Yes
M	56.4	Unknown	Anchorage	Blood	Cellulitis	1	None	Yes
M	58	Non-Native	Anchorage	Blood	Septic arthritis	91	Chronic lung disease	Yes
M	58.2	AK Native	Anchorage	Blood	Meningitis	11	Alcohol abuse, diabetes	No
F	58.9	Non-Native	Anchorage	Blood	Pneumonia	91	Smoking, chronic lung disease, alcohol abuse, diabetes	Yes
M	58.9	AK Native	Anchorage	Blood	Cellulitis, necrotizing fasciitis	11	Alcohol abuse	Yes
F	58.9	AK Native	Other	Blood	Bacteremia	89	Alcohol abuse	Yes
F	59	Non-Native	Anchorage	Blood	Septic arthritis, cellulitis	28	Chronic lung disease	Yes
F	59.1	AK Native	Other	Tissue	Cellulitis, necrotizing fasciitis	11	Smoking, chronic lung disease, alcohol abuse	Yes
F	59.1	AK Native	Anchorage	Blood	Cellulitis	11	Alcohol abuse	Yes
M	59.9	Non-Native	Anchorage	Blood	Cellulitis	6	Smoking, diabetes	Yes
M	60.3	Non-Native	Other	Tissue	Cellulitis, osteomyelitis	ND	Diabetes	Yes
F	60.7	Non-Native	Anchorage	Blood	Bacteremia	95	Diabetes	Yes
M	61.4	AK Native	Anchorage	Blood	Pneumonia, cellulitis, strep toxic shock	91	Smoking, chronic lung disease, alcohol abuse	No
F	62.5	Non-Native	Anchorage	CSF	Empyema, pneumonia	1	Chronic lung disease	Yes
M	63	Non-Native	Anchorage	Blood	Cellulitis	91	Diabetes	Yes
M	63.4	Non-Native	Anchorage	Blood	Cellulitis	ND	None	Yes
F	63.9	AK Native	Anchorage	Tissue	Cellulitis	89	Alcohol abuse	Yes
M	64.1	Non-Native	Anchorage	Blood	Bacteremia	91	Diabetes	Yes
F	64.2	Non-Native	Anchorage	Blood	Cellulitis	1	None	Yes
M	66.3	Non-Native	Anchorage	Blood	Cellulitis, osteomyelitis	ND	Chronic lung disease, alcohol abuse	Yes
F	67	Non-Native	Anchorage	Blood	Cellulitis	ND	Immune suppressive therapy	Yes
M	67.3	Non-Native	Anchorage	Blood	Empyema, pneumonia, cellulitis	11	Smoking, chronic lung disease, alcohol abuse	Yes
M	68.2	Non-Native	Anchorage	Blood	Cellulitis	53	Smoking, chronic lung disease	Yes
M	68.5	Non-Native	Other	Blood	Cellulitis	11	Chronic lung disease, diabetes	Yes
F	69.2	AK Native	Anchorage	Tissue	Cellulitis, osteomyelitis	91	Chronic lung disease, alcohol abuse	Yes
F	69.7	AK Native	Other	Tissue	Cellulitis	91	Smoking, alcohol abuse	Yes
F	70.1	AK Native	Other	Blood	Bacteremia	4	None	Yes
F	71	AK Native	Other	Tissue	Septic arthritis, strep toxic shock, osteomyelitis	91	Alcohol abuse	Yes
M	71.3	Non-Native	Anchorage	Blood	Cellulitis	87	Chronic lung disease, diabetes	Yes
F	72.8	Non-Native	Anchorage	Blood	Bacteremia	91	Alcohol abuse	No
M	72.8	Non-Native	Other	Tissue	Septic arthritis	ND	None	Yes
F	74.8	AK Native	Anchorage	Blood	Cellulitis	91	Chronic lung disease, immune suppressive treatment	Yes
F	76.6	AK Native	Anchorage	Blood	Pneumonia, cellulitis	91	Chronic lung disease	Yes
F	76.6	Unknown	Anchorage	Blood	Cellulitis	111	Chronic lung disease	No
M	76.6	AK Native	Other	Blood	Pneumonia	91	Chronic lung disease	No
M	92	Non-Native	Other	Blood	Bacteremia	ND	Diabetes	No
F	95.3	Non-Native	Anchorage	Blood	Cellulitis	1	None	No

*ND = typing not done

Invasive group B *Streptococcus*

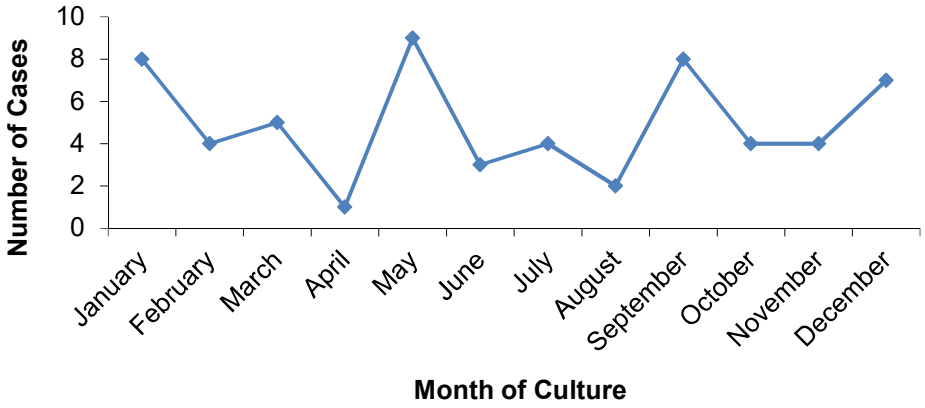
Overall Incidence

A total of 59 cases of invasive group B *Streptococcus* (GBS) were reported to AIP in 2015. The overall rate of invasive GBS disease in the state of Alaska was 8/100,000 persons per year. The Alaska rate is similar to the ABCs 2015 national projected rate of 8.9/100,000 [14]. In 2015, there were four GBS-related deaths for a case fatality ratio of 6.8%.

Seasonality

Cases of group B *Streptococcus* occurred throughout the year with no apparent trends in seasonality.

Figure 20: Invasive group B *Streptococcus*, by Month of Culture - Alaska, 2015



Race

In 2015, 25% of invasive group B *Streptococcus* cases in Alaska occurred in the Alaska Native population. The age-adjusted rate ratio of invasive GBS disease for the Alaska Native population compared with the non-Native population in 2015 was 1.7.

Table 21: Invasive group B *Streptococcus* Cases by Race – Alaska, 2015

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	15 (25)	11.1	73	0 (0)
Non-Native	44 (75)‡	6.5	57	4 (9.1)
Total	59		61	4 (6.8)

*Cases per 100,000 per percent distribution of Alaska 2010 population
‡Includes 7 cases for which race was unknown

Region

In 2015, 37 (63%) of the 59 reported GBS cases occurred in Anchorage; 11 cases were reported in the Interior, seven cases in Southeast, two in Kotzebue and one case each in Bristol Bay the YK Delta regions. The highest rates of disease occurred in the Kotzebue region (23.4/100,000) and Bristol Bay (13.9/100,000).

Age

Invasive group B *Streptococcus* cases reported in 2015 ranged in age from newborn to 92 years old; the median age was 60.8 years. Highest rates of disease overall occurred in children less than two years old (42.4/100,000 persons per year).

Figure 21: Invasive group B *Streptococcus* by Age Group - Alaska, 2015

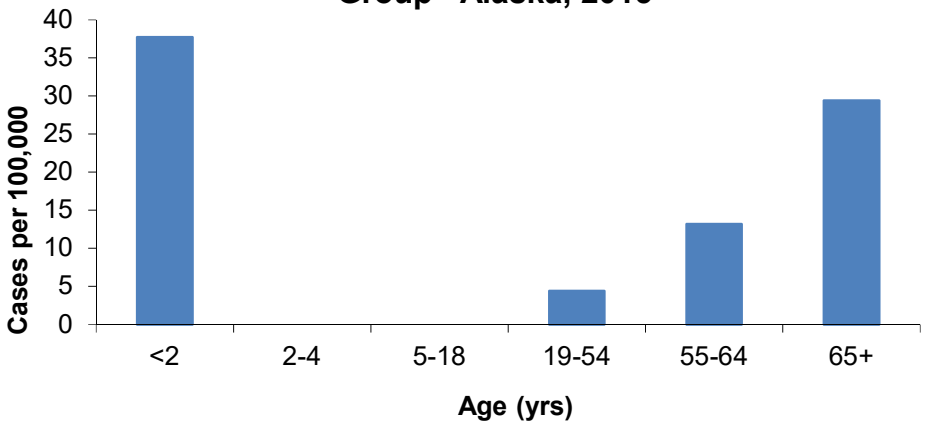
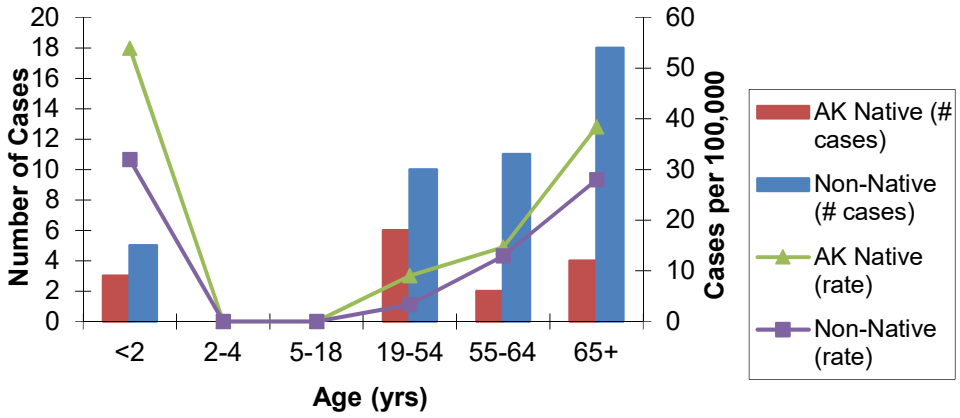


Figure 22: Invasive group B *Streptococcus*, Cases & Rates by Age Group & Race - Alaska, 2015



When stratified by race, the highest rates of disease occurred in AK Native and non-Native children less than two years old, 53.9/100,000 persons per year and 32/100,000 persons per year, respectively. There was one case of early-onset disease (less than 7 days old) for a rate of 0.1 cases per 1,000 live births.

Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the GBS infection was recorded as the primary clinical presentation. In 2015, the most common clinical presentations were cellulitis and bacteremia which occurred in 18 (30%) and 17 (29%) cases, respectively.

Group B *Streptococcus* was isolated from blood in 37 (63%) of 59 cases in 2015; 13 cases were isolated from tissue specimens, three each from bone and joint fluid, and one each from cerebrospinal fluid, peritoneal fluid, and amniotic fluid.

Table 22: Primary Clinical Presentations of Invasive group B *Streptococcus* – Alaska, 2015

Primary Presentation	n (%)
Cellulitis*	18 (30)
Bacteremia	17 (29)
Osteomyelitis	7 (12)
Septic arthritis	6 (10)
Pneumonia*	4 (7)
Endocarditis	2 (3)
Meningitis	2 (3)
Amnionitis	1 (2)
Empyema	1 (2)
Peritonitis	1 (2)
Total	59

*with bacteremia

Associated Risk Factors

The presence of one or more associated risk factors was reported in 83% of invasive GBS cases in 2015. Diabetes was the most prevalent risk factor observed in adults followed by cigarette smoking and chronic lung disease.

Table 23: Associated Risk Factors Identified in Invasive GBS Cases – Alaska, 2015*

Medical Condition/Risk Factor	Adult Cases (≥ 18 years) n=51, Cases (%)
Diabetes	28 (55%)
Cigarette smoking	9 (18%)
Chronic lung disease	6 (12%)
Alcohol abuse	4 (8%)
Injection drug use	1 (2%)
Immunosuppressive treatment	1 (2%)
Asplenia	0 (0%)

*More than one risk factor was identified in several cases

Antibiotic Resistance

Susceptibility testing was performed on 42 GBS isolates received in 2015. Results of the testing are presented in the following table.

Table 24: Antibiotic Resistance in Invasive group B *Streptococcus* Isolates – Alaska, 2015

Antibiotic	Susceptible	Intermediate	Resistant	I + R	Total Tested
Penicillin	42 (100%)	0 (0%)	0 (0%)	0 (0%)	42
Ceftriaxone	42 (100%)	0 (0%)	0 (0%)	0 (0%)	42
Erythromycin	19 (45%)	0 (0%)	23 (55%)	23 (55%)	42
Tetracycline	11 (26%)	0 (0%)	31 (74%)	31 (74%)	42
Levofloxacin	42 (100%)	0 (0%)	0 (0%)	0 (0%)	42
Clindamycin	30 (71%)	0 (0%)	12 (29%)	12 (29%)	42

All isolates tested were susceptible to penicillin, ceftriaxone, and levofloxacin. Resistance to tetracycline, erythromycin, and clindamycin was seen in 74%, 55%, and 29%, respectively, of isolates tested. Of the two early onset cases, one isolate was available for susceptibility testing; the isolate was resistant to erythromycin and tetracycline.

Table 25: Summary of Invasive group B *Streptococcus* Case Characteristics, Alaska, 2015

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Associated Risk Factors	Survived
F	Newborn	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	14 days	AK Native	Other	Blood	Meningitis	None	Yes
F	0.1	Unknown	Anchorage	Blood	Bacteremia	None	Yes
M	0.1	Non-Native	Anchorage	Blood	Septic arthritis	None	Yes
F	0.2	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
M	0.2	AK Native	Anchorage	CSF	Meningitis	None	Yes
M	0.5	Unknown	Other	Blood	Bacteremia	None	Yes
F	24.4	Unknown	Anchorage	Amniotic fluid	Amnionitis	None	Yes
M	32	Non-Native	Other	Tissue	Septic arthritis	None	Yes
M	34.4	AK Native	Other	Tissue	Osteomyelitis	Smoking	Yes
M	36	Non-Native	Anchorage	Tissue	Cellulitis	Diabetes	Yes
F	40.7	AK Native	Anchorage	Bone	Cellulitis	Smoking, diabetes, injection drug use	Yes
F	44.2	Non-Native	Other	Blood	Endocarditis, pneumonia	Smoking, alcohol abuse	No
M	44.4	AK Native	Other	Blood	Bacteremia	Chronic lung disease, diabetes	Yes
F	45.9	Non-Native	Other	Blood	Pneumonia	None	Yes
M	48	AK Native	Other	Tissue	Cellulitis	Smoking	Yes
F	50.3	AK Native	Anchorage	Blood	Bacteremia	Chronic lung disease, diabetes	Yes
F	50.5	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
M	50.5	Unknown	Anchorage	Tissue	Cellulitis, osteomyelitis	Diabetes	Yes
M	51.2	Non-Native	Other	Tissue	Cellulitis	Diabetes	Yes
M	52.5	AK Native	Anchorage	Blood	Cellulitis, osteomyelitis	Diabetes	Yes
M	54.1	Non-Native	Other	Tissue	Cellulitis, osteomyelitis	Diabetes	Yes
M	54.5	Non-Native	Anchorage	Blood	Septic arthritis	Diabetes	Yes
F	55.5	Non-Native	Other	Tissue	Cellulitis	Diabetes	Yes
M	56.6	Non-Native	Anchorage	Blood	Bacteremia	Diabetes	Yes
M	59.5	Non-Native	Anchorage	Peritoneal fluid	Peritonitis	Diabetes	Yes
M	59.7	Non-Native	Anchorage	Blood	Septic arthritis	Diabetes	Yes
M	60.8	Non-Native	Anchorage	Blood	Cellulitis	Diabetes	Yes
M	61.2	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	61.4	Non-Native	Anchorage	Blood	Cellulitis	Immune suppressive therapy	Yes
M	62.5	Non-Native	Anchorage	Blood	Cellulitis	None	Yes
M	62.5	Non-Native	Anchorage	Blood	Cellulitis	Diabetes	Yes
M	62.8	AK Native	Other	Tissue	Osteomyelitis	Smoking, alcohol abuse	Yes
F	62.9	Unknown	Anchorage	Bone	Cellulitis	Diabetes	Yes
M	63.9	Non-Native	Other	Tissue	Empyema, cellulitis	Chronic lung disease, diabetes	Yes
M	64.2	AK Native	Anchorage	Bone	Osteomyelitis	Diabetes	Yes
M	65.1	Non-Native	Anchorage	Blood	Cellulitis	None	Yes
F	66.6	Non-Native	Other	Blood	Cellulitis	Diabetes	Yes
F	66.6	Non-Native	Other	Tissue	Cellulitis, osteomyelitis	Diabetes	Yes
M	66.9	Non-Native	Anchorage	Joint fluid	Septic arthritis, cellulitis	Diabetes	Yes
M	67.5	AK Native	Anchorage	Blood	Cellulitis	Smoking	Yes
M	68.6	AK Native	Anchorage	Blood	Bacteremia	Smoking	Yes
M	69	Non-Native	Anchorage	Blood	Cellulitis	None	Yes
M	70.8	AK Native	Other	Blood	Bacteremia	Diabetes	Yes
M	71.6	Non-Native	Anchorage	Blood	Bacteremia	Alcohol abuse	Yes
M	72.8	Non-Native	Anchorage	Blood	Bacteremia	Diabetes	Yes
M	73.7	Non-Native	Other	Blood	Pneumonia	Chronic lung disease	No
F	74.5	Non-Native	Other	Tissue	Pneumonia, septic arthritis	None	Yes
F	75.7	Unknown	Anchorage	Tissue	Cellulitis, osteomyelitis	Diabetes	Yes
M	77.4	Non-Native	Anchorage	Blood	Cellulitis	None	Yes
F	78	Non-Native	Anchorage	Blood	Pneumonia	Smoking	Yes
F	78.2	Unknown	Other	Blood	Bacteremia	Chronic lung disease, diabetes	Yes
M	81	AK Native	Other	Blood	Bacteremia	Chronic lung disease	Yes
F	82.4	Non-Native	Anchorage	Blood	Endocarditis	None	Yes

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Associated Risk Factors	Survived
M	82.8	Non-Native	Anchorage	Joint fluid	Septic arthritis	Diabetes	Yes
M	84.8	Non-Native	Anchorage	Blood	Cellulitis	Diabetes	Yes
F	87.4	Non-Native	Other	Blood	Bacteremia	Smoking, alcohol abuse	No
F	92	Non-Native	Anchorage	Blood	Bacteremia	Diabetes	No

References

1. State of Alaska, Department of Labor & Workforce Development. From http://laborstats.alaska.gov/pop/popest.htm

2. Centers for Disease Control and Prevention. 2015. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, *Streptococcus pneumoniae*, 2015.

3. Hennessy TW, Singleton RJ, Bulkow LR, Bruden DL, Hurlburt DA, Parks, D, Moore M, Parkinson AJ, Schuchat A, Butler JC. Impact of heptavalent pneumococcal conjugate vaccine on invasive disease; antimicrobial resistance and colonization in Alaska Natives: progress towards elimination of a health disparity. *Vaccine* 2005;23:5464-73.

4. Singleton RJ, Hennessy TW, Bulkow LR, Hammitt LL, Zulz T, Hurlburt DA, Butler JC, Rudolph K, Parkinson A. Invasive pneumococcal disease caused by nonvaccine serotypes among Alaska Native children with high levels of 7-valent pneumococcal conjugate vaccine coverage. JAMA 2007;297(16):1784-92.

5. Wenger JD, Zulz T, Bruden D, Singleton R, Bruce MG, Bulkow L, Parks D, Rudolph K, Hurlburt D, Ritter T, Klejka J, Hennessy T. Invasive pneumococcal disease in Alaskan children: impact of the seven-valent pneumococcal conjugate vaccine and the role of water supply. *Pediatr Infect Dis J* 2010;29: 251-256.

6. State of Alaska, Department of Health & Human Services. Retrieved 5/2/16 from http://www.epi.hss.state.ak.us/bulletins/docs/b2009_24.pdf

7. Clinical and Laboratory Standards Institute (CLSI). *Performance Standards for Antimicrobial Susceptibility Testing; Nineteenth Informational Supplement.* 2009; 29(3): M100-S19. p.21.

8. Rudolph K, Bulkow L, Bruce M, Zulz T, Reasonover A, Harker-Jones M, Hurlburt D, Hennessy T. Molecular resistance mechanisms of macrolide-resistant invasive Streptococcus pneumoniae isolates from Alaska, 1986 to 2010. *Antimicrobial Agents and Chemotherapy* 2013;57 (11): 5415-22.

9. Centers for Disease Control and Prevention. 2015. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, *Haemophilus influenzae*, 2015.

10. Hammitt LL, Block S, Hennessy TW, DeByle C, Peters H, Parkinson A, Singleton R, Butler JC. Outbreak of invasive *Haemophilus influenzae* serotype a disease. *Pediatr Infect Dis J* 2005;24(5): 453-6.

11. Bruce MG, Zulz T, DeByle C, Singleton R, Hurlburt D, Bruden D, Rudolph K, Hennessy T, Klejka J, Wenger JD. *Haemophilus influenzae* serotype a invasive disease, Alaska, USA, 1983-2011. *Emerg Infect Dis* 2013;19(6): 932-7.

12. Centers for Disease Control and Prevention. 2015. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, *Neisseria meningitidis*, 2015.

13. Centers for Disease Control and Prevention. 2015. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, Group A *Streptococcus*, 2015.

14. Centers for Disease Control and Prevention. 2015. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, Group B *Streptococcus*, 2015.

Appendix

MIC Interpretive Standards Definitions:

CLSI [7] provides recommended interpretive categories for various Minimum Inhibitory Concentration values (cut points) for each organism/antibiotic combination which are defined as follows:

1. Susceptible (S):

The "susceptible" category implies that isolates are inhibited by the usually achievable concentrations of antimicrobial agent when the recommended dosage is used for the site of infection.

2. Intermediate (I):

The "intermediate" category includes isolates with antimicrobial agent MICs that approach usually attainable blood and tissue levels and for which response rates may be lower than for susceptible isolates. The "intermediate" category implies clinical efficacy applicability in body sites where the drugs are physiologically concentrated (e.g., quinolones and β-lactams in urine) or when a higher dosage of a drug can be used (e.g., β-lactams). The "intermediate" category also includes a buffer zone which should prevent small, uncontrolled technical factors from causing major discrepancies in interpretations, especially for drugs with narrow pharmacotoxicity margins.

3. Resistant (R):

Resistant strains are not inhibited by the usually achievable concentrations of the agent with normal dosage schedules, and/or that demonstrate MICs or zone diameters that fall in the range where specific microbial resistance mechanisms are likely (e.g., β-lactamases) are likely, and clinical efficacy of the agent against the isolate has not been reliably shown in treatment studies.